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Original Article

# Anterior segment parameters and intraocular pressure changes after phacoemulsification in pseudoexfoliation syndrome

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**Abstract**

**Aim:** The aim of this study was to compare anterior segment and intraocular pressure changes in eyes with and without pseudoexfoliation after cataract surgery.

**Materials and Methods:** This prospective study included 35 eyes of 35 patients (Group 1) without pseudoexfoliation and 40 eyes of 37 patients with pseudoexfoliation (Group 2) undergoing elective phacoemulsification surgery. The anterior segment was evaluated preoperatively and one week, and one and three months postoperatively using a Sirius-Scheimflug device. Intraocular pressures were measured using Goldman applanation tonometry. Central corneal thickness, anterior chamber volume, anterior chamber depth, anterior chamber angle, and corneal volume parameters were evaluated among the anterior segment parameters.

**Results:** A statistically significant difference was observed between Group 1 and Group 2 in terms of pre- and postoperative anterior chamber volume, anterior chamber depth, anterior chamber angle and intraocular pressure values ($p < 0.001$). Central corneal thickness was higher in the group with pseudoexfoliation at first week and first month measurements ($p < 0.05$). Corneal volume was significantly higher in Group 2 at all pre-and post-operative measurements.

**Conclusion:** According to the findings of this study, phacoemulsification surgery causes changes in intraocular pressure and anterior segment parameters. Additionally, these changes occur more dramatically in pseudoexfoliative cataracts.

**Keywords:** Anterior chamber; cataract; intraocular pressure; phacoemulsification; pseudoexfoliation syndorme

## INTRODUCTION

Pseudoexfoliation syndrome (PEX) is a clinical presentation characterized by white fibrogranular deposits (1). Thirty percent of the affected population worldwide is reported to be above 60 years of age. The prevalence of PEX increases with age (2).

Zonular hooks, by which zonular fibers bind to the lens epithelium, exhibit significant changes in this disease. PEX fibril bands radiate from neighboring epithelial cells, impair the regular capsular structure, and occupy the zonular lamellae, resulting in disjointed zonulae that no longer adhere to the capsular surface. The same phenomenon occurs on the ciliary epithelium. These events cannot initially be discerned behind the iris, but are detected from disconnected zonulae, phacodonesis, and lens subluxation. Dilatation of the rigid pupilla is difficult due to the accumulated material (1,3). The complication rate is high in case of coexistence of cataract and pseudoexfoliation (4).

Anterior segment parameters such as anterior chamber depth (ACD) and anterior chamber angle (ACA) are known to change after cataract surgery and intraocular lens (IOL) implantation (5).

The aim of this study was to compare changes in anterior chamber parameters and intraocular pressure after phacoemulsification in patients with and without PEX.

## MATERIALS and METHODS

### Patients and control groups

Patients presenting to the Adiyaman University Training and Research Hospital Ophthalmology Outpatient Clinic, Turkey, between January and October 2016 were included in the study. Patients found to have coexisting PEX and cataract were included in the patient group. Routine cataract patients were included in the control group. Patients with previous histories of ophthalmic surgery or trauma, corneal pathology, uveitis, glaucoma, or posterior segment pathology or using systemic or

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topical medications capable of affecting anterior chamber parameters and intraocular pressure (IOP), as well as previous histories of corneal laser applications, were not included in the study. Patients with intraoperative or postoperative complications (failure to complete capsulorhexis, iris prolapse, posterior capsule perforation, corneal burns, zonular dialysis, postoperative fibrin or decompensated edema, or corneal suture requirement) were also excluded. Informed consent was obtained from all participants. Adiyaman University Ethics Committee approval was received for this research (2015/07-4).

**Preparation of patients before surgery**

All participants underwent ophthalmological examination. Corrected and non-corrected visual testing was carried out using a Snellen chart. Keratometric values were measured using an autokeratorefractometer (Topcon KR-8100, Tokyo, Japan). Following biomicroscopic examination, anterior segment evaluation was performed with a Sirius Scheimpflug device. IOP measurements were taken using a Goldmann applanation tonometer three times a day, and the mean values were recorded. The patient's pupils were then dilated, the lenses were examined and fundus examinations were performed. In cases in which the posterior segment could not be evaluated due to the density of the cataract, B-scan ultrasonography was applied.

**Surgical technique**

All operations were performed by a single surgeon with the patient under topical anesthesia. Once the site of the corneal incision (upper or temporal) had been determined based on the keratometric measurements, three planned corneal incisions with a width of 3.2 mm were applied. Capsulorhexis with a diameter of 5.5–6 mm was performed. After hydrodissection, the nucleus was emulsified using the stop and chop technique. After cleaning the cortex with bimanual irrigation/aspiration, foldable IOLs were placed inside the capsule, and 1 mg/ml of cefuroxime (0.4 cc) was given intracamerally.

**Postoperative follow-up**

Postoperative antibiotic topical drops, topical steroid, and non-steroid anti-inflammatory drops were administered four times a day. Patients were invited for control examinations at one week, one month, and three months, postoperatively. Corrected and non-corrected vision was determined at control examinations using a Snellen chart. Following anterior segment evaluation with the Sirius Scheimpflug device, IOPs were measured using the Goldmann applanation tonometer.

**Statistical Analysis**

Statistical analysis was carried out on SPSS 17.0 software. Parametric tests were employed since the variables were normally distributed. The independent-samples t-test was used to compare the two groups, while the paired-samples t-test was used to compare the pre- and postoperative results for each group. The Chi-square test was employed to compare qualitative variables. Friedman test statistics were used to check for differences in repeated measurements between the two groups.

## RESULTS

Thirty-five eyes of 35 cataract patients who underwent phacoemulsification surgery were included as the control group (Group 1), and 40 eyes of 37 patients with pseudoexfoliation and cataract who underwent phacoemulsification were enrolled as the study group (Group 2).

Eighty percent of the patients included in the study were men (n = 60) and 20% (n = 15) were women. Patients' mean age was 69.52 years (± 9.35). There was no statistically significant difference between the groups in terms of gender or age (p=0.286).

**Table 1. Comparison of patient parameters between the study groups**

| | Group 1 (n=35) mean±SD | Group 2 (n=40) mean± SD | t value | p value |
|---|---|---|---|---|
| **Age** | 68.22 ±11.99 | 70.65 ±6.15 | -1.120 | 0.286 |
| **Pre-op** | | | | |
| CCT | 0.52 ±0.03 | 0.53 ±0.487 | -1.813 | 0.074 |
| ACD | 2.57 ±0.50 | 2.67 ±0.39 | -1.008 | 0.317 |
| ACV | 123.86 ±35.89 | 118.60 ±29.87 | 0.696 | 0.489 |
| ACA | 37.11 ±11.86 | 39.40 ±6.85 | -1.037 | 0.303 |
| CV | 49.75 ±4.24 | 52.94 ±7.42 | -2.238 | 0.028* |
| IOP | 14.68 ±3.88 | 17.99 ±2.64 | -4.264 | 0.001* |
| **1st week** | | | | |
| CCT | 0.52 ±0.05 | 0.56 ±0.06 | -2.820 | 0.006* |
| ACD | 3.24 ±0.51 | 3.22 ±0.42 | 0.19 | 0.845 |
| ACV | 146.57 ±35.33 | 150.15 ±38.24 | -0.419 | 0.67 |
| ACA | 47.08 ±11.87 | 48.02 ±8.16 | -0.403 | 0.688 |
| CV | 50.74 ±4.80 | 62.07 ±16.15 | -4.226 | 0.001* |
| IOP | 12.85 ±2.04 | 15.47 ±2.61 | -4.861 | 0.001* |

| | | | | |
|---|---|---|---|---|
| **1st month** | | | | |
| CCT | 0.50 ±0.08 | 0.54 ±0.05 | -2.691 | 0.009* |
| ACD | 3.33 ±0.61 | 3.30 ±0.33 | 0.203 | 0.84 |
| ACV | 146.08 ±37.81 | 152.27 ±27.58 | -0.817 | 0.41 |
| ACA | 45.40 ±12.23 | 50.00 ±6.34 | -2.081 | 0.0051 |
| CV | 47.75 ±4.43 | 56.33 ±5.47 | -7.389 | 0.0001* |
| IOP | 14.40 ±2.59 | 16.70 ±3.52 | -3.180 | 0.002* |
| **3rd month** | | | | |
| CCT | 0.51 ±0.66 | 0.54 ±0.04 | 1.193 | 0.206 |
| ACD | 3.31 ±0.51 | 3.38 ±0.28 | -0.709 | 0.482 |
| ACV | 145.02 ±36.48 | 155.30 ±25.57 | -1.425 | 0.158 |
| ACA | 45.77 ±12.45 | 51.85 ±5.83 | -2.644 | 0.011 |
| CV | 47.87 ±4.13 | 56.67 ±4.50 | -8.762 | 0.001* |
| IOP | 14.37 ±2.96 | 15.05 ±2.65 | -1.038 | 0.299 |

*p<0.05 Paired Samples Test, SD: Standard deviation

**Table 2. Comparison of groups by visits**

| | Group 1 ( n=35) | | Group 2( n=40) | |
|---|---|---|---|---|
| | p | t | p | t |
| **1.CCT** | | | | |
| preop -postop 1st week | 0.011* | -2.694 | 0.000* | -3.887 |
| postop 1st week-postop1st month | 0.009* | 2.763 | 0.002* | 3.258 |
| postop 1st month-postop 3rd month | 0.383 | -0.884 | 0.861 | 0.77 |
| **2.ACD** | | | | |
| preop -postop 1st week | 0.000* | -7.735 | 0.000* | -6.431 |
| postop 1st week-postop1st month | 0.225 | -1.235 | 0.126 | -1.564 |
| postop 1st month-postop 3rd month | 0.836 | 0.209 | 0.155 | -1.448 |
| **3.ACV** | | | | |
| preop -postop 1st week | 0.000* | -5.355 | 0.000* | -4.519 |
| postop 1st week-postop1st month | 0.795 | 0.262 | 0.614 | -0.508 |
| postop 1st month-postop 3rd month | 0.311 | 1.027 | 0.109 | -1.639 |
| **4.ACA** | | | | |
| preop -postop 1st week | 0.000* | -6.923 | 0.000* | -5.560 |
| postop 1st week-postop1st month | 0.013* | 2.628 | 0.034* | -2.204 |
| postop 1st month-postop 3rd month | 0.196 | -1.319 | 0.004* | -2.037 |
| **5.CV** | | | | |
| preop -postop 1st week | 0.092 | -1.736 | 0.001* | -3.570 |
| postop 1st week-postop1st month | 0.000* | 5.468 | 0.038* | 2.145 |
| postop 1st month-postop 3rd month | 0.742 | -0.332 | 0.66 | -0.443 |
| **6.IOP** | | | | |
| preop -postop 1st week | 0.002* | 3.320 | 0.000* | 7.022 |
| postop 1st week-postop1st month | 0.000* | -4.656 | 0.034* | -2.202 |
| postop 1st month-postop 3rd month | 0.94 | 0.076 | 0.002* | 3.304 |

*p<0.05 Paired Samples Test

Central corneal thickness (CCT) was higher in the study group compared to the control group in the first week and first month, postoperatively (p=0.006 and p=0.009, respectively) (Table 1). In both groups, a significant increase in CCT values in the first week was followed by a decrease at the first month (p <0.05).

An increase was observed in ACD values in all post-operative measurements in both groups compared to pre-operative values (p <0.001). However, there was no significant difference in ACD values between the two groups (p>0.05) (Table 2).

While an increase was determined in all post-operative ACV measurements compared to pre-operative values in both groups (p <0.001), no significant difference was found in ACV values between the groups (p> 0.05).

A significant increase was determined in all post-operative ACA measurements in both groups compared to pre-operative values (p <0.001). Each post-operative ACA measurement in the study group was higher than the previous value (p=0.000, p=0.034, and p=0.004).

Pre-operative and all post-operative CV values were higher in the study group (p=0.028, p=0.001, p=0.0001, and p=0.001). The increase in CV in the first week was significant only in Group 2 (p=0.001). CV values decreased at first month measurements in both groups (p=0.000 and p=0.038, respectively). Finally, CV values were higher than pre-operative values in both groups at the third month (p=0.003 and p=0.004).

Pre-operative, and postoperative first week and first month IOP were all higher in the study group (p = 0.001, p=0.001, and p=0.002, respectively). IOP decreased in both groups in the first week (p=0.002 and p=0.000, respectively), and then increased in the first month (p=0.000 and p=0.034). IOP values then decreased in the third month in both groups, but only significantly in Group 2 (p=0.002). No statistically significant difference was observed in three-month IOP values between the groups (p=0.299).

## DISCUSSION

PEX commonly affects the anterior segment of the eye. Iris pigment deposits and pseudoexfoliative material deposits can be seen on the posterior surface of the cornea. Changes in the aqueous content due to an increase in blood aqueous barrier permeability can affect corneal metabolism (6). The number of endothelial cells decreases during and after cataract surgery, and various structural changes lead to dysfunction (7). Moderate damage to the corneal endothelium during surgery causes a temporary increase in corneal thickness, measured using pachymetry. It should be noted that while endothelial damage may be the most important cause of this increase, there may be several other potential etiologies. No significant difference was determined in unilateral PEX cases between the two eyes in terms of mean endothelial cell numbers and morphological endothelial parameters in one study, but a significant difference was observed compared with a control group (8). Another study reported greater corneal thickness in eyes with PEX. The authors attributed the difference between the groups to a lower number of endothelial cells in eyes with PEX and to morphological changes in those cells (9). A study evaluating CCT before phacoemulsification and one hour, one day, and one week after surgery reported a 13.81% increase in healthy corneas in the early postoperative period, but that this increase returned to normal levels within one week (10). In a similar study, Falkenberg et al. demonstrated an average increase of 37 µm in CCT on the first postoperative day, and returning to preoperative values within an average of 27 weeks (11). Takmaz et al. measured CCT at 545.7 ± 36.2 µm before cataract surgery and at 550.5 ± 40.2 µm in the first postoperative month, although this increase was not statistically significant (12). In a similar study by Yağcı et al., no significant difference was found between CCT values in the first postoperative month and preoperative measurements (13). Bilak et al. reported that CCT increased significantly from 531.0 ± 38.99 µm before phacoemulsification to 533.72 ± 44.87 µm postoperatively. It has been reported that this increase is probably due to endothelial stress occurring during phacoemulsification (14). In the present study, in accordance with the literature, CCT measurements increased in both groups compared with the first preoperative week. While the CCT increase in the control group at one week postoperatively normalized at one month, this was not observed in the PEX group. Continued CCT elevation at one week, one month, and three months postoperatively may have been due to changes in endothelial cell numbers and morphological changes in PEX syndrome caused by a disruption of endothelial functions.

Huang et al. found that IOP decreased significantly in the third postoperative month compared with the preoperative period. Those authors reported that this decrease was correlated with an increase in ACD and angle patency (15). Bilak et al. reported significantly lower IOP in the first month (12.30 ± 3.32 mm Hg) compared with the preoperative period (14.75 ± 4.12 mm Hg). Positive correlation between IOP change and preoperative IOP, and negative correlation between IOP change and preoperative ACD were also noteworthy (14). In the present study, IOP was significantly lower in the control group in the first postoperative week. However, no significant change was observed at the first month and third month visits compared with the preoperative period.

A study comparing IOP in PEX and control groups after phacoemulsification reported a significant decrease in IOP measurements at three months, six months, and one year postoperatively compared with preoperative values. In the control group, only the six-month decrease was significant, and no significant difference was observed at the next visit at one year (16). According to Aalia et al., the IOP decrease in PEX patients was greater at all measurements postoperatively (17). Preoperative IOP was significantly higher in patients with PEX who underwent uneventful phacoemulsification surgery, compared with the control group. A significant decrease was observed between

preoperative and postoperative one-month mean IOP values, and the authors emphasized that IOP was stable at three months postoperatively. They also stated that the decline in IOP was more prominent in the PEX group. This may be due to removal of pseudoexfoliative material by fluid flow during surgery, expansion of ACA by insertion of a thin IOL, and also a long-term increase in aqueous humor flow (18). Studies have reported a significant decrease in IOP among PEX cases after cataract surgery, but no significant difference compared with control groups (19,20). In the present study, and consistent with the literature, a significant decrease was observed in IOP at all postoperative visits compared with preoperative measurements in the study group. In the control group, the significant IOP decrease occurring in the first week was not observed at subsequent measurements. The decrease in IOP may be related to increase ACD due to surgery, increased ACA, and a consequent increase in aqueous humor outflow. Long-term reduction of IOP may also be achieved by removing exfoliative material from anterior chamber structures in the study group.

Numerous studies have reported that phacoemulsification increases ACA (21,22). Phacoemulsification seems to be beneficial for cataract patients with chronic angle closure due to expanding ACA (23,24). A significant increase in ACA was observed in both control and PEX patients after phacoemulsification in the present study. This enlargement is probably associated with posterior displacement of the iris-lens diaphragm due to the thinner IOL replacement.

Tafti et al. reported an increase in ACD after phacoemulsification in patients with PEX. The noteworthy point of that study is that pre-op ACD and ACD change were inversely correlated. However, the effect of PEX on the results could not be evaluated due to the absence of a control group (25). There have been insufficient studies of the effect of phacoemulsification surgery on ACD with PEX. A significant increase was observed in ACD values in the PEX patients in the present study. Moreover, ACD measurements in the PEX patients were not significantly different from those of the control group, either preoperatively or postoperatively.

Bilak et al. evaluated CV using Sirius and reported a significant increase in postoperative values with uneventful phacoemulsification (14). In another study, Suzuki et al. evaluated CV before and after phacoemulsification using Pentacam from the central 3 mm and 10 mm areas. Their results indicated that CV in the central 3 mm area returned to its original value, while CV in the 10 mm area remained significantly higher (26). Those authors suggested that the increase in CV in the central cornea was caused by endothelial damage, and emphasized the importance of viscoelastic use. In a similar study by Doğanay et al., CV measurements were taken from the from corneal 3 mm, 5 mm, and 7 mm areas, and no significant difference was observed at one, three, or six months postoperatively (27). In accordance with the previous literature, the mean CV value in the PEX group in the present study was significantly higher in the postoperative period. The CV values of the PEX group were significantly higher compared with the control group at all preoperative and postoperative measurements. Greater endothelial stress because of PEX may play a role in this difference.

No significant difference was found between PEX and a control group in terms of ACV values in one study (28). In another study, however, PEX and non-PEX conjugate eye groups exhibited lower ACV values compared to a control group (29). There was no significant difference between the PEX and control groups in the present study in terms of preoperative values. Some studies have shown a significant increase in ACV values after phacoemulsification (30,12). However, there is a notable lack of research into ACV values after phacoemulsification in PEX patients. In the present study, a significant ACV increase was observed postoperatively in both the control and PEX groups. The increase in ACV was greater in the PEX group, although the difference was not statistically significant.

## CONCLUSION

IOP and anterior segment parameters changed in both groups in the present study, more markedly in the PEX group. It should be remembered that appropriate precautionary measures will be required in these PEX cases in order to obtain more stable postoperative IOP and anterior chamber values.

****The summary of this study was presented as a poster at the TOD winter symposium (24-25 January 2020 / Antalya)*

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